SUMMARIES OF PRE-CAMBRIAN LITERATURE OF NORTH AMERICA

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VI. THE CORDILLERA OF THE UNITED STATES

The most notable advances in the study of the pre-Cambrian of the Cordillera are the finding of pre-Cambrian sediments unconformably below the Lower Cambrian of the southern Sierra Nevada of California by Knopf and Kirk; additions to our knowledge of the extent and composition of the belt series; and the epoch-making investigations of the life-record of the Beltian by Walcott.

Bastin and Hill[1] report that the principal rocks underlying Gilpin County, Colorado, and adjacent parts of Clear Creek and Boulder counties are of pre-Cambrian age. The Idaho Springs formation, a quartz biotite schist of sedimentary origin, is really the most important. Sedimentary origin is inferred from the highly aluminous composition of certain phases, apparent bedding, highly quartzose and certain apparently conglomeratic phases, lime silicate phases probably representing metamorphosed limestone, and the lack of evidence of intrusive relations.

Other pre-Cambrian rocks of the area include stocks of granite gneiss, quartz diorite, and hornblendite, and the younger Silver Plume granite. Granite pegmatites of various ages are abundant.

Blackwelder and Crooks[2] state that the Medicine Bow range, west of Laramie, Wyoming, contains one of the most varied sections in the western United States. They include the basal schist gneiss complex above which are more than 25,000 feet of slightly

[1] E. S. Bastin and James M. Hill, "Economic Geology of Gilpin County and Adjacent Parts of Clear Creek and Boulder Counties, Colorado," *U.S. Geol. Surv., Prof. Paper 94* (1917), 379 pp., 23 pls., 79 figs.

[2] E. Blackwelder and H. F. Crooks, "Pre-Cambrian Rocks in the Medicine Bow Mountains of Wyoming," *Geol. Soc. Am. Bull.*, Vol. XXIX (1918), pp. 97–98.

metamorphosed sediments consisting of quartzites, slates, dolomites, lava flows, pyroclastics, and tillites. Detailed studies have been made.

Butler and Loughlin[1] report that the pre-Cambrian rocks of the Cottonwood–American Fork mining region of Utah, southwest of Park City, consists mainly of shallow-water deposits of quartzites, schists, and slates about 11,000 feet thick. They dip steeply to the north. At the top of the section is a conglomeratic layer resembling tillite.

The St. Joe–Clearwater[2] region of Idaho, comprising about 250 square miles, lies about 30 miles to the southeast of the Coeur d'Alene lead-mining district. The Algonkian sediments exposed in this area include mica schists and quartzites which are correlated with those of the Coeur d'Alene district. The base on which they rest is not exposed. The formation of this area which is correlated with the St. Regis of the Coeur d'Alene lacks the purple color assumed to be characteristic in the type locality. The most difficult correlation was that of the beds believed to correspond to the Newland formation, since they are many times thicker than in the Coeur d'Alene district.

The region around Mullan, Idaho, and Saltese, Montana,[3] overlaps the southeast part of the Coeur d'Alene quadrangle. The pre-Cambrian rocks exposed belong to the Algonkian belt series and include the following formations:

Striped Peak formation—Chiefly greenish gray and some purple beds of shale and sandstone with shallow water markings

Newland (Wallace) formation	5,000± feet	Blue shale of variable thickness—5,000 feet to insignificant. Blue- and white-banded argillite with some greenish beds, with some limestone beds. Chiefly green colored calcareous rocks with argillaceous beds

[1] B. S. Butler and G. F. Loughlin, "A Reconnaissance of the Cottonwood–American Fork Mining Region, Utah," *U.S. Geol. Surv. Bull. 620* (1915), pp. 165–226, 1 pl.

[2] F. C. Calkins and E. L. Jones, Jr., "Geology of the St. Joe–Clearwater Region, Idaho," *U.S. Geol. Surv. Bull. 530* (1913), pp. 75–86, 1 pl.

[3] F. C. Calkins and E. L. Jones, Jr., "Economic Geology of the Region around Mullan, Idaho, and Saltese, Montana," *U.S. Geol. Surv. Bull. 540* (1912), pp. 167–211, 1 pl. (map).

Ravalli group
- St. Regis formation, 1,000± feet—Shales and quartzites of prevailingly green and purple tints with shallow water markings
- Revelt quartzite, 1,200 feet—Thick bedded, in part sericitic, but mostly clean quartzite
- Burke formation, 2,000 feet—Fine-grained, light-colored, thin-bedded siliceous quartzites and shales

Crawford and Worcester[1] report that the pre-Cambrian rocks of the Gold Brick district of Gunnison County, Colorado, include mica, cordierite-mica, garnet, amphibole, quartz, granitic, and hornblendic schists of which some are probably altered sediments. Quartzites and pyroxenic quartzites, quartzite conglomerate, andalusite quartz rocks, and epidote rocks also occur. Certain granite and diorite intrusion are probably pre-Cambrian.

Exposures of quartzite and schist or shale[2] belonging to the Algonkian Uncompahgre formation are found in the Piedra Canyon of the San Juan region.

Darton[3] states that granite is the pre-Cambrian rock of Luna County, New Mexico.

Darton[4] reports that the pre-Cambrian rocks of the Deming quadrangle of southern New Mexico consist of granite with subordinate gneissic granite and diorite.

Duncan[5] describes the pre-Cambrian rocks of Harney Peak, South Dakota, as consisting of mica, hornblende, garnet schists intruded by granite and associated with greisen, pegmatite, and quartz veins.

The Philipsburg quadrangle[6] lies in the central western part of Montana. The Belt series is unconformably overlain by the

[1] R. D. Crawford and P. G. Worcester, "Geology and Ore Deposits of the Gold Brick District, Colorado," *Colorado Geol. Surv. Bull. 10* (1916), 116 pp., 9 pls., 4 figs.

[2] Whitman Cross and E. S. Larsen, "Contributions to the Stratigraphy of Southwestern Colorado," *U.S. Geol. Surv. Prof. Paper 90* (1914), pp. 39–50, 1 pl., 2 figs.

[3] N. H. Darton, "Geology and Underground Water of Luna County, New Mexico," *U.S. Geol. Surv. Bull. 618* (1916), 188 pp., 13 pls., 15 figs.

[4] N. H. Darton, "Description of the Deming Quadrangle, New Mexico," *U.S. Geol. Surv. Geol. Atlas, Folio No. 207* (1917), 15 pp., 5 pls. (maps and illus.), 11 figs.

[5] Gordon A. Duncan, "Contribution to the Study of the Pre-Cambrian Rocks of the Harney Peak District of South Dakota," *Trans. Am. Inst. Min. Eng.*, Vol. XLIII (1913), pp. 207–18, 3 figs.

[6] W. E. Emmons and F. C. Calkins, "Geology and Ore Deposits of the Philipsburg Quadrangle, Montana," *U.S. Geol. Sur., Prof. Paper 78* (1913), 271 pp., 17 pls.

Cambrian Flathead quartzite. This relation is expressed by angular disconformity of bedding and by a basal conglomerate. The Belt formations of this area are correlated with those of the Walcott's Belt Mountain section. The only difficulty in this correlation lies in the absence in the Philipsburg district of beds equivalent to the Greyson shale. The Beltian succession of the Philipsburg district is as follows:

Unconformity

Spokane shales—Shale and sandstone, the prevailing in upper portion, color chiefly red, some cracks, and ripple marks, 5,000 feet

Greyson shales—Apparently lacking, may be included in Newland

Newland limestone—Thin-bedded, more or less siliceous and ferruginous passing into shale, generally buff on weathered surface. Shallow water markings in upper part, 4,000 feet

Ravilli quartzite—Gray with some dark bluish and greenish shale, 2,000 feet

Prichard shales—Dark bluish interbedded with sandstone, rusty brown on weather surface, 5,000± feet

Neipart quartzite—Light colored. Base not exposed. 1,000± feet

Finlay[1] reports that the pre-Cambrian rocks of the Colorado Springs quadrangle consist chiefly of the Pikes Peak granite in which are minor inclusions of acid gneisses and schists. Two other granites and some pegmatite and syenite dikes are included in the pre-Cambrian.

Haynes[2] finds the following pre-Cambrian rocks in the vicinity of Three Forks, Montana:

Empire shale—Even-bedded green shales, interlayered with quartzite. Thickness, 800 feet, (?)

Spokane formation—Well-stratified red and green slates interlayered with mud cracked and ripple-marked sandstone. Thickness, 1,650+ feet.

From studies of the Wardner district quartzite, Hershey[3] adds the Cataldo to the base of Calkins' Belt section.

[1] G. I. Finlay, "Description of the Colorado Springs Quadrangle, Colorado," *U.S. Geol. Surv., Folio 203* (1916), 17 pp., 7 pls., 9 figs.

[2] W. P. Haynes, "The Lombard Overthrust and Related Geological Features," *Jour. Geol.*, Vol. XXIV (1916), pp. 269–90, 11 figs.

[3] O. H. Hershey, "The Belt and Pelona Series," *Am. Jour. Sci.*, 4th Ser., Vol. XXXIV (1912), pp. 263–73.

The Belt series,[1] according to Walcott, unconformably underlies the Middle Cambrian Flathead quartzite. In ascending order the members exposed are the Spokane shale, Empire shale, Helena limestone, and Marsh shale. The total thickness is 3,300 feet at Helena, of which the Helena limestone comprises 2,400 feet.

Knopf and Kirk[2] report that pre-Cambrian rocks underlie with marked erosional unconformity the Lower Cambrian of the Inyo range of southern California. The pre-Cambrian system from the top downward consists of the following:

Deep Spring formation—Local sandstone and dolomite beds, 1,600 feet
Reed dolomite—2,000 feet
? Sandstones and thin-bedded, impure dolomites, 2,000 feet (?)

Both Archean and Algonkian[3] are exposed in the Shinumo quadrangle. They are separated by a well-marked unconformity characterized by angular discordance of structures, difference in metamorphism, and intrusives.

The Archean is composed of the Vishnu schists including quartz, mica, and hornblende schists. They are cut by Archean quartz diorite and granite pegmatite intrusives.

The Algonkian section is as follows:

Unconformity
Dox sandstone—Cross-bedded, ripple-marked in part, mud-cracked argillaceous layers. 2,297 feet plus unknown thickness removed by pre-Cambrian erosion
Shinumo quartzite—Hard, compact, cross-bedded sandstone and quartzite, usually of fine and even grain. 1.564 feet
Hakatai shale—Argillaceous red shale grading upward into arenaceous red shale and sandstone. Nearly all beds contain sun cracks and ripple marks. Metamorphosed by a thick diabase sill. 580 feet

[1] Adolph Knopf, "Ore Deposits of the Helena Mining District, Montana," *U.S. Geol. Sur. Bull. 527* (1913), 143 pp., 7 pls., 4 figs.

[2] A. Knopf, "A Geologic Reconnaissance of the Inyo Range and the Eastern Slope of the Southern Sierra Nevada, California," with a section on the stratigraphy of the Inyo range, by Edwin Kirk, *U.S. Geol. Surv. Prof. Paper 110* (1918), 130 pp., 32 pls., 8 figs.

[3] L. F. Noble, "The Shinumo Quadrangle, Grand Canyon District, Arizona," *U.S. Geol. Surv. Bull. 549* (1914), 100 pp., 18 pls. (incl. map in pocket), 1 fig.

Bass limestone—White crystalline limestone alternating with beds of argillaceous and calcareous red shale containing sun cracks, cut by thick diabase sill. 335 feet

Hotauta conglomerate—Arkose conglomerate characterized by lack of sorting and transportation. Rests on an even surface of erosion. 0–6 feet

Unconformity

Detailed study of the Vishnu series is lacking, but it is thought to be equivalent to the Pinal schists of the Bisbee district.

Paige[1] reports that the pre-Cambrian rocks of the Silver City folio of southwestern New Mexico are granites with minor quartzitic and schistose masses, the whole being mapped as a unit.

Patton[2] *et al.* state that the pre-Cambrian rocks in the Alma district of Park County, Colorado, consist mostly of granitic and banded gneisses and acid schists, granites, pegmatites, and aplites.

Ransome[3] presents ten Paleozoic sections ranging from southern to northern Arizona. In each section Cambrian is unconformably above pre-Cambrian. The pre-Cambrian rocks in these sections are as follows:

District	Pre-Cambrian Rocks
Bisbee	Pinal schists (sericitic schist chiefly metamorphosed sediments cut by granite)
Tombstone	Pinal schist and gneissic quartz-mica diorite
Clifton	Pinal schist and granite
Globe and Ray quadrangles	Pinal schist and intrusive granitic rocks
Roosevelt	Granite
Southern part of the Ancha district	Granite
Northern part of the Ancha district	Granite, older pre-Cambrian schists, younger pre-Cambrian quartzite, and conglomerate

[1] Sidney Paige, "Description of the Silver City Quadrangle, New Mexico," *U.S. Geol. Surv., Atlas Folio No. 199* (1916), 19 pp., 4 pls., 17 figs.

[2] H. B. Patton, A. J. Hoskins, and M. G. Butler, "Geology and Ore Deposits of the Alma District, Park County, Colorado," *Colorado State Geol. Surv. Bull. No. 3* (1912), 284 pp., 29 pls., 6 figs.

[3] F. L. Ransome, "Some Paleozoic Sections in Arizona and Their Correlation," *U.S. Geol. Surv. Prof. Paper 98* (1916), pp. 133–66, 8 pls., 4 figs.

District	Pre-Cambrian Rocks
Head of Canyon Creek	Hornblende rock and schist
Jerome	Schist
Grand Canyon	Grand Canyon series, younger pre-Cambrian including over 4,700 feet of conglomerate, limestone, shale, quartzite, and sandstone resting unconformably on schist of older pre-Cambrian

All the pre-Cambrian rocks in the foregoing sections excepting some of the Grand Canyon and northern Ancha sections are older pre-Cambrian.

Richardson[1] finds that in the region of Castle Rock folio lying between Denver and Colorado Springs, only the youngest of the pre-Cambrian rocks of the Front Range, the Pikes Peak granite is exposed.

Richardson[2] finds that the pre-Cambrian rocks of the Van Horn quadrangle of southwestern Texas are unconformable below the Cambrian and they consist of the following:

Millicon formation—Fine red sandstone, cherty limestone, and conglomerate; in northern Carrizo Mountains

Relations concealed

Carrizo formation—Quartzite, slate, and a variety of schists; in southern Carrizo Mountains

Schultz[3] finds that the pre-Cambrian rocks of southeastern Idaho and western Wyoming include schists, granites, gneisses, and igneous rocks cut by dikes of pegmatite and diabase. Some of the schists and gneisses may be of sedimentary origin. The pre-Cambrian area lies in the central and eastern part of the Teton range.

[1] G. B. Richardson, *United States Geological Survey, Castle Rock Folio No. 198* (1915).

[2] G. B. Richardson, "Description of the Van Horn Quadrangle, Texas," *U.S. Geol. Surv. Geol. Atlas, U.S. Van Horn Folio (No. 194)* (1914), 9 pp., 5 figs., 3 maps, illustration sheet.

[3] A. R. O. Schultz, "Geologic Reconnaissance for Phosphate and Coal in Southeastern Idaho and Western Wyoming," *U.S. Geol. Surv. Bull. No. 680* (1918), pp. 84, 2 pls., 8 figs.

Smith and Packard[1] state that certain rocks possibly of pre-Cambrian age have been found in Oregon. They include a granodiorite near the head of John Day River and certain amphibolite, hornblendite, mica quartz schists, and talc schists near the California-Oregon boundary.

Smith[2] states that the pre-Cambrian of California comprises schists and gneisses of Inyo, San Bernardino, and Riverside counties. These underlie Olenellus beds. They also include the Pelona schists of San Bernardino County, the Abrams and Salmon schists of Trinity and Siskiyou counties, the South Fork Mountain schists, and certain old schists and gneisses mapped with the Sierra batholith. Similar rocks also occur in the Sierra Madre.

Somers[3] states that the pre-Cambrian rocks of the Burro Copper district of southwestern New Mexico consist of a complex of granites.

Umpleby[4] reports that in a reconnaissance survey of northwestern Custer County, Idaho, he has found highly metamorphosed schists, slates, and quartzites of Algonkian age, which probably represent a part of the Coeur d'Alene section. The sequence in Custer County was not worked out in detail.

Walcott[5] cites evidence for the unconformity of the Cambrian and pre-Cambrian at Helena, Montana. The specific facts referred to are slight angular discordance, in places an erosion surface on the pre-Cambrian formations, and fossil relationship.

Walcott[6] regards the pre-Cambrian Algonkian limestones of the Cordilleran region of North America as owing their origin chiefly

[1] W. D. Smith and E. L. Packard, "The Salient Features of the Geology of Oregon," *Jour. Geol.*, Vol. XXVII (1919), pp. 79–120.

[2] J. P. Smith, "The Geologic Formations of California with Reconnaissance Geologic Map," *Cal. State Min. Bur. Bull. No. 72* (1916), 47 pp., tables.

[3] R. E. Somers, "Geology of the Burro Mountains Copper District, New Mexico," *Am. Inst. Min. Eng. Bull. No. 101* (May, 1915), pp. 957–96, 25 figs.; *Bull. No. 108*, p. 2476.

[4] Joseph B. Umpleby, "Some Ore Deposits in Northwestern Custer County, Idaho," *U.S. Geol. Surv. Bull. 539* (1913), 100 pp., 10 pls., 4 figs.

[5] C. D. Walcott, "Relations between the Cambrian and Pre-Cambrian Formations in the Vicinity of Helena, Montana," *Smithsonian Misc. Coll.*, Vol. LXIX, No. 4 (June 24, 1916), pp. 259–301, 6 pls., 4 figs.

[6] C. D. Walcott, "Pre-Cambrian Algonkian Algal Flora," *Smithsonian Misc. Coll.*, Vol. LXIV, No. 2 (1914), pp. 77–156, pls. 4–23.

to the action of bacteria and algae. Bacterial remains have not been identified in pre-Cambrian rocks, but numerous concretionary forms have been found in the Newland limestone of the Belt series. These forms are similar to the calcareous bodies formed by modern blue-green algae in fresh-water lakes. Chains of silicified cells which resemble the cell chains of modern blue-green algae were also found. The similarities of structure between the pre-Cambrian and modern algoid forms are clearly demonstrated by a series of plates. Eight Algonkian algal forms are described by Walcott as occurring in the Newland limestone. The Greyson shale overlying the Newland limestone has numerous crustacean remains—*Beltina danai* and many annelid trails representing five species. The next overlying formation of the Belt series, the Spokane shales, is credited with one species of algae.

Walcott[1] briefly describes bacteria which he discovered in the Newland limestone, a formation of the Beltian series of Montana.

The pre-Cambrian rocks[2] of the Dillon quadrangle include the Belt series, 3,000 feet thick, which are composed of slates, thin-bedded quartzite, and schists. They are unconformably above a series of schists and gneisses interbedded with limestones 5,000 feet thick which are correlated with the Cherry Creek group.

VII. THE CORDILLERA OF CANADA

Notable advances have been made in the study of the pre-Cambrian of the southern portion of the Rocky Mountain section by Daly, Schofield, and others. The pre-Cambrian in this section consists of two units, an older complex of clastic and chemical sediments, the Priest River terrane, Shuswap series, etc., folded and metamorphosed, and intruded by granites. The stratigraphic separation of this older unit has not been fully accomplished. Unconformably overlying the basal rocks is a thick series of feebly metamorphosed clastic sediments and limestones, the Belt series, having characteristics of terrestrial sediments. They are coarsest and most fragmental in the western part of the section where they

[1] C. D. Walcott, "Discovery of Algonkian Bacteria," *Nat. Acad. Sci.* (1915), pp. 256–57, 3 figs.

[2] A. N. Winchell, "Mining Districts of the Dillon Quadrangle, Montana and Adjacent Areas," *U.S. Geol. Surv. Bull. No. 574* (1914), 191 pp., 8 pls., 16 figs.

are exposed in contact with the older rocks. Different views as to the upper limits of the Belt series have been held. Daly believed that they were conformable with the Cambrian. Schofield reports that he has found an unconformity at the base of the Middle Cambrian and places the top of the Beltian much higher than Daly.

Allan[1] states that between Banff and Golden in the valley of Bow River along the Canadian Pacific Railway the pre-Cambrian section is as follows: Base not exposed. Corral Creek formation, 1,320 feet composed of quartzites and coarse-grained sandstones with interbedded shales. Hector formation, 4,590 feet, gray, green, purple, siliceous shale with interbedded conglomerates. Remains of brachiopod-like shells in certain beds. Disconformable contact with Cambrian above.

The rocks[2] along the international boundary between the Porcupine and Yukon rivers, classified provisionally as pre-Cambrian, lie on the north side of the Yukon and are peripheral to a larger area of these rocks south of the river. They comprise amphibolites, quartzite schists, mica schists, and occasional limestone beds.

According to Daly,[3] the succession of the Rocky Mountains along the forty-ninth parallel from the Clark range on the western margin of the Great Plains to the Selkirk on the one hundred and seventeenth meridian include the pre-Beltian Priest River terrane; the Beltian; Lower, Middle, and Upper Cambrian; and on the western border of the area, later conformable Paleozoic rocks. The only regional unconformity lies between the Beltian and pre-Beltian.

The pre-Beltian Priest River terrane consists of an undetermined thickness of dynamically metamorphosed sediments, notably mica schists, phyllites, quartzites, chlorites, schists, and dolomites whose stratigraphic order is unknown. The thickness exposed may be about 18,000 feet. They outcrop along the eastern base

[1] John E. Allan, *International Geog. Congress, Twelfth Guide Book* (1913), pp. 167–201, maps 2, prints.

[2] DeLorme D. Cairnes, "The Yukon-Alaska International Boundary between Porcupine and Yukon Rivers," *Canada Geol. Surv. Mem. No. 67* (1914), 161 pp., 2 maps (in pocket), 2 figs., 16 pls.

[3] R. E. Daly, *Geology of the North American Cordillera at the Forty-ninth Parallel* (1912), 3 parts, 840 pp., 73 pls., 42 tables, 17 geologic maps.

of the Selkirk Mountain system in parallel bands striking about north 15° east.

The succession overlying the Priest River terrane is sedimentary with the exception of an extensive basal lava flow, the Purcell lava which occurs in the eastern portion. The extent of the latter makes it a good horizon marker. Geographically, this succession is classified from west to east as the Summit, Purcell, Galton, and Lewis series. The Summit series of the Selkirks is the only one whose base is exposed. It unconformably overlies the Priest River terrane. The various members of these series are correlated with reference to their position above or below the Purcell lava, their mineralogical constituents, and general lithological characteristics, special emphasis being laid upon the molar tooth structure of certain carbonate formations due to the weathering of a peculiar mixture of dolomite and limestone, the presence of a certain orthoclase feldspar with a characteristic microperthitic intergrowth, the presence or absence of red iron oxide, etc. In the Selkirks the sediments are chiefly clastic, conglomerates being important at the base. To the eastward, these grade into finer-grained clastics and carbonate. The easternmost part of the series is composed dominantly of carbonates. Red color is also more prominent in the more easterly series especially in their upper portions.

The only fossils found are the species *Beltina danai* which occur in the Altyn limestone in the lower portion of the Lewis series. This limestone and the one underlying it are classed as Beltian.

The Beltian and Cambrian beds are bent into open nearly north and south trending folds which are disturbed by normal faults, most of which trend in the same direction as the folds. The Lewis series has been pushed over the Mesozoic sediments of the Great Plains along a thrust fault dipping westward at a low angle.

In the case of the Lewis series, the Altyn dolomite and the Waterton dolomite below it are referred to the Beltian because of the presence of *Beltina danai* in the Altyn. The basis for the separation of the series into Beltian and Cambrian is not so apparent. The correlation of the beds designated as Cambrian is based chiefly on the lithological similarity of the Siyeh limestone with the

fossiliferous Castle Mountain limestone of McConnell's Castle Mountain–Bow River series on the Canadian Pacific Railway.

Daly bases his correlation of the other formations on their position with respect to the Siyeh and their lithologic resemblance to certain members of McConnell's sections. Willis placed all of the Lewis series in the Beltian since the *Beltina danai* beds of the Altyn formation are conformable with the overlying beds of the series, whereas in the Belt range the Cambrian unconformably overlies the Beltian and is separated from the *Beltina danai* bearing beds by 7,700 feet of sediments. Walcott also found a plane of unconformity at the base of the Fairview sandstone, the lowest Cambrian in the Bow River section.

Daly[1] describes the rocks along the Canadian Pacific Railway, between Golden and Kamloops, British Columbia.

Pre-Cambrian rocks dominate in this section. He classifies them into the Beltian and pre-Beltian or Shuswap. The two are separated by an unconformity. His divisions of the Shuswap or pre-Beltian follows:

	Formation	Approximate Thickness in Feet
	Unconformity with Beltian System	
Intrusive	Batholiths, laccoliths, sills, dykes, and chonoliths of granite, aplite, and pegmatite, generally metamorphosed	
Shuswap series	Adams Lake basic volcanics (with contemporaneous basic intrusives)	10,000+
	Tshinakin limestone-metargillite	3,900
	Bastion schists (phyllites, etc.)	5,000
	Sicamous limestone (representative of Dawson's "Nisconlith" series)	3,200
	Salmon Arm mica schists	1,800
	Chase quartzite	3,000
	Tonkawatla paragneiss (?)	1,500+
Base concealed		
		28,400

The existence of the individual members of this series is certain, but their relative thickness is still in doubt with the exception of the Tshinakin limestone and the Sicamous limestone.

[1] R. A. Daly, "A Geological Reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway," *Canada Geol. Surv. Mem. No. 68*, 1915, 260 pp., 7 maps, 46 pls., 4 figs.

The pre-Beltian area forms a core surrounded by Beltian and other younger rocks. It is roughly lenticular in outline, its longest direction extending from northwest to southeast. It is about 400 miles in length and 100 miles in width. The quartzites in this series represent true sandstones, probably derived from a granitic area. Daly believes that the intrusions in the pre-Beltian are of a type characteristic only of the early pre-Cambrian and resemble the Laurentian granites of the Canadian Shield. Sills and *lit par lit* injections are characteristic. The metamorphism of the pre-Beltian, he believes, is due almost entirely to the weight of overlying beds and to temperature. The facts on which this conclusion is based are the parallelism of the fissility and the bedding, the almost complete absence of ordinary folds, the low dip of the beds, and the parallel fissility of the dykes with that of the adjacent beds. Metamorphism of this type, Daly believes, is typical of the pre-Cambrian only. He ascribes it to a steep temperature gradient of the earth's crust and to the abundance of mineralizers in the granitic intrusions of that time. The pre-Beltian of this area, he believes, is probably correlated with the Priest River terrane to the south, the only difference between the two being that as yet no granites have been found in the latter. Equivalent rocks also probably occur on the west shore of Coeur d'Alene Lake.

The Beltian system of the area is classified as follows:

COLUMNAR SECTION OF THE BELTIAN SYSTEM IN THE SELKIRK

		Approximate Thickness in Feet
Top, erosion surface		
Glacier Division ("Selkirk series" of Dawson)	Ross, quartzite (in part)	2,500
	Nakimu limestone	350
	Cougar formation (quartzite with metargillitic beds)	10,800
Albert Canyon Division "Nisconlith series" of Dawson	Laurie formation (metargillite, often calcareous; with subordinate interbeds of limestone and quartzite; basal bed, limestone 50 feet thick)	15,000
	Illecillewaet quartzite	1,500
	Moose metargillite	2,150
	Limestone (marble)	170
	Basal quartzite	280
		32,750
Base, unconformity with Shuswap terrane		

The source of this great thickness of sediments, Daly believes, is the older pre-Beltian terrane, the principal evidence for this being the graduation of coarser sediments to finer in going from west to east. Another fact in favor of this is that the quartzites commonly contain fragments of alkaline feldspar. The quartzites, he believes, are partly dune and loess deposits. The limestones, because of their fine grain, he ascribes to direct chemical precipitation. Most of the sediments are well bedded and consist chiefly of quartz, striated feldspar, and clayey material. Frequently, they show ripple marks and mud cracks.

The Roosville, Phillips, and Rateway[1] formations classified by Daly in his forty-ninth parallel report as Middle Cambrian are assigned by Schofield to the Beltian because the Roosville is unconformably overlain by the fossilferous Middle Cambrian Burton formation. Both the Purcell and the Galton series of Daly are placed in the pre-Cambrian.

The unconformity between the Burton and the Roosville is not shown by discordance of bedding, but by a basal hematite conglomerate of the Burton, the occurrence of other materials in the Burton which are inferred to have been derived from the Roosville, the striking difference in the metamorphism of the Burton as compared with the formations underlying it, and the occurrence of cryptozoan forms in the formations underlying the Burton.

Schofield[2] describes the Cranbrook area of southeastern British Columbia.

The area is in the southern part of the Purcell Mountains and includes about 50 square miles. The Beltian pre-Cambrian rocks underlie most of the area. Schofield's classification of these rocks follows.

[1] S. J. Schofield, "The Pre-Cambrian (Beltian) Rocks of Southeastern British Columbia, and Their Correlation," *Canada Geol. Surv. Mus. Bull. No. 2* (July 3, 1914), pp. 79–91, 1 fig. (map).

[2] S. J. Schofield, "Geology of Cranbrook Map-Area, British Columbia," *Canada Geol. Surv. Mem. No. 76* (1915), 245 pp., 1 map, 33 pls., 15 figs.

Cambrian	Erosion: early Cambrian uplift
Pre-Cambrian (Beltian) Purcell series	Gateway formation: (continental deposition), sandstones, sandy argillites, some concretionary siliceous dolomite. Salt casts and ripple marks
	Purcell lava, Purcell sills: intrusion of gabbro accompanied by outpouring of basalt over land surface
	Siyeh formation: (mainly continental, some possibly marine deposition), red, purple, and green mud-cracked argillites, ripple-marked sandstones, some limestones
	Kitchener formation: (continental and possibly marine deposition), calcareous argillites, argillaceous quartzites ripple marked, mud-cracked, some limestones
	Creston formation: shallow water deposition, quartzites, argillaceous quartzites, mud cracks, and ripple marks
	Aldridge formation: argillaceous quartzites, some conglomerates